USDA/STATE/EPA ASSESSMENT TEAM OF THE
NATIONAL AGRICULTURAL PESTICIDE IMPACT ASSESSMENT PROGRAM
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Economic Analysis of Ethylene Oxide Uses in Agriculture

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USDA/STATE and EPA Ethylene Oxide Assessment Team

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USDA/STATE/EPA Cooperative Response to RPAR on Ethylene Oxide (ETO)

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I. INTRODUCTION AND SUMMARY

Purpose of Analysis

This report investigates the benefits of the use of the pesticide ethylene oxide (ETO) in agriculture (quarantine programs, stored products, beehives and USDA laboratories). This analysis is intended as an input to the risk/benefit decision by the Administrator of EPA as to the continued registration of ethylene oxide (ETO) under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (FIFRA) (7 U.S.C. 135 et. seq.).

A notice of rebuttable presumption against registration (RPAR) of ETO was issued in the Federal Register Vol. 43, No. 19, on January 27, 1978. If the data on human health and/or environmental risks cited in the RPAR are not successfully rebutted and risks appear to outweigh benefits, the Administrator of EPA may announce intent to cancel pesticidal registration of ETO under FIFRA. This report presents the economic benefits of the continued use of the pesticide in question, as mandated by FIFRA. This report is preliminary and subject to further analysis and revision during the RPAR process including: interagency review, a public comment period, and public hearings (if held).

Scope and Approach

This report presents the results of use-by-use economic analyses of the principal agricultural uses of ETO. The information presented in this report corresponds to a specification of requirements for an economic impact analysis that appeared in the Federal Register Vol. 41, No. 102 on May 25, 1976. The notice required that the preliminary analysis identify the major and minor uses of the pesticide, estimate the quantities utilized, identify the registered alternatives and their availability, determine the change in pesticide costs

associated with use of alternatives, and evaluate the regulatory impact upon crop production and retail prices. This analysis focuses on the most economically important uses of ETO, which include: beehives, quarantine programs, USDA research laboratories, and stored products.

The general approach was to evaluate impacts of shifting to alternative materials at the user level. Social/community effects were not investigated in detail because of the general inability to quantify impacts on users and consumers as indicated in the economic impact analyses.

The alternative materials considered in this analysis were identified by agricultural scientists working in the area as controls most likely to be adopted for use by users now treating with ETO. All alternatives used for the site/pest combinations in the analysis are currently registered with EPA.

Summary of Findings

ETO is used only for specific site/pest combinations. Cancellation of ETO registrations would result in the increased risk of certain agricultural and/or human pests becoming a serious problem in this country. The magnitude of the losses are difficult to estimate.

The production of ETO in the United States was estimated at 5.3 billion pounds. The ETO Assessment Team estimated that about 868,000 pounds of ETO are used annually in agriculture. Quarantine uses amount to 5793 pounds; beehive fumigation, 1500 pounds; stored products, 860,000 pounds; and USDA research laboratories, 500 pounds.

The most critical use of ETO is in high containment agricultural research laboratories. These laboratories conduct basic and applied research on

domestic and exotic plant and animal diseases, serve as the introduction point for exotic plant species, and test exotic biological agents for plant pests. ETO is used in these laboratories only where there are no alternative treatments. Increased operating costs were estimated to be $1.1 million. Often, research techniques and equipment were designed to be used with ETO decontamination. It is possible that over the longer term researchers and equipment manufacturers could redesign research techniques and equipment to eliminate the reliance on ETO as a decontaminant. This would require technological innovations which cannot be forecast.

ETO is used in the APHIS quarantine program to destroy certain snail species on equipment being returned to this country and to decontaminate plant parts being imported for testing by private firms. There are no alternative treatments for these uses. Currently, it does not seem likely that in the short-term an acceptable alternative to ETO could be developed. One can not project long term developments. Importation of plant parts would cease under APHIS Quarantine Regulations. It is possible that firms would conduct tests on plant parts in other countries. This would depend on the expected returns.

Beekeepers who utilize ETO treatments under State Disease Control Programs would revert to burning hives to control disease spread at a cost of about $500,200. The potential impact here is the loss of this new disease control program which has not been fully developed or evaluated.

ETO is used on stored products to reduce microbial populations which contribute to food spoilage and are possible health hazards.

The loss of ETO for use on stored products would have minor impacts if importers could have the products treated outside this country. ETO treatments could be conducted at a foreign location without any significant cost impacts if there were no detectable residues. Information on ETO residues in stored products was not available.

Without the alternative of using ETO treatments outside this country, stored product processers would have to analyze stored products for unacceptable microbial infestations and reject those not acceptable. The loss of those stored products currently treated (about 25 percent by volume) would be expected to have market impacts. Data was not available to estimate the magnitude of these impacts.

Limitations

These analyses have several significant limitations which need be mentioned in this summay.

1. Information was not available from the Department of Defense to value equipment treated with ETO.
2. All information regarding the use of ETO on stored products came from the stored product industry. There were no alternative information sources.
3. The analysis of ETO use on beehives was on a new use of ETO which has not yet obtained nationwide registration.

ECONOMIC ANALYSIS OF ETHYLENE OXIDE USE IN QUARANTINE PROGRAMS

INTRODUCTION

This report presents the results of the economic analysis of cancelling the use of ethylene oxide (ETO) in quarantine programs. ETO is used as a fumigant by the USDA Animal and Plant Health Inspection Service (APHIS) to prevent the introduction into this country of agricultural pests. The primary pests for which ETO is used are various species of plant eating land snails. The primary threat of these snails being introduced has been on military equipment being returned to the continental United States from snail host regions. When returning equipment is found to be contaminated with any of the forbidden pests, APHIS requires decontamination or prohibits entry of the equipment into this country. ETO is one of several techniques used to prevent entry of these pests on equipment.

ETO is also used by APHIS to treat certain imported plant materials. Examples include: cottonseed from Australia, India and New Zealand; wheat from Italy; rice seed and straw from Brazil, Japan, and the Philipines; and corn from South Africa. These plant materials, as propagative material, normally would be prohibited entry because of the danger of introducing certain plant diseases. These diseases, if introduced into this country, could cause economic damage to agriculture. The imported plant materials are used in trial processing tests with machinery, food testing, or for chemical analysis. U.S. companies conduct these tests to develop new markets for their products in other countries or to find new products to import into and market in this country.

Current ETO Use

ETO treatment of equipment and miscellaneous cargo being brought into this country is sporadic. There were 23 and 64 tarpaulin fumigations with ETO conducted in 1976 and 1977, respectively (7). Most snail interceptions at ports of entry have been found on retrogade military materials. When practical, returning military equipment is treated with steam or methyl bromide. However, both steam and methyl bromide can render equipment with electronic components unusable; methyl bromide should not be used on certain types of rubber, and steam treatment will not always destroy certain snail species.

Treatment of plant materials with ETO is also limited. It was estimated that less than 25 fumigations are conducted annually on between 1,000 and 2,000 pounds of plant materials being imported into this country (27). Plant material treatments are conducted in vacuum evaluated fumigation chambers usually by the APHIS staff. These particular plant material imports cannot be treated with any other agent to successfully destroy possible plant diseases without damaging the material for its intended use.

The usage for tarpaulin fumigation of military equipment in 1976 and 1977 was 4,356 and 7,185 pounds a.i. of ETO. Total annual use in the plant material program was estimated at 23 pounds a.i. or 1.25 pounds a.i. per treatment (7).

Alternatives

There are no effective alternative chemical treatments for the programs discussed above which do not cause damage. If equipment and plant materials could not be decontaminated with ETO, they would be prohibited entry into this country.

ECONOMIC ANALYSIS

The military equipment treated with ETO usually contains high valued electronic equipment, such as communications equipment or weapons with electronic components (2). Due to the classified nature of most of this equipment, estimates of the value of equipment treated were not available. If this type of equipment could not be treated with ETO, the material would either have to be destroyed, stored outside this country, or subjected to a methyl bromide fumigation with unacceptable damage. Each alternative would increase the cost of government operations and reduce the ability of the military to move equipment.

As discussed above, companies import plant materials as part of research and development programs. The benefits of research and development are uncertain and accrue over an extended period of time. The uncertainity and the time period involved both tend to complicate the process of measuring the benefits of these activities.

Companies testing plant materials could have the materials tested under contract outside this country. Companies may be reluctant to do this because of possible loss of trade secrets. The alternatives are either not to conduct the tests or to establish (temporary or permanent) test facilities outside this country. These decisions would depend on the expected returns to the firm wishing to conduct the tests and on the capital available to the firm.

The current treatments are conducted sporadically and for different companies. A single company would find it costly to set up facilities to conduct tests outside this country. Given that these tests are conducted under conditions where the returns are uncertain, any cost increase can be expected to reduce the willingness of firms to engage in this research

and development. These increased costs of conducting the tests could exceed the expected net returns to the firm from successful development of the products.

A sample of import permits was obtained to provide an indication of uses of ETO (6). All of the permits were for testing by firms attempting to find export markets. This sample information and discussions with an APHIS representative indicated that most testing is in an attempt to develop export markets for machinery or chemicals.

Representatives of several companies were contacted in an attempt to determine the effect of a prohibition of entry of plant materials on these firms and on U.S. exports (1,3,4,5). The responses varied from no significant problems conducting tests elsewhere to increased costs making it financially impossible to conduct the tests at an alternate location. These responses appeared to be related to the origin of the plant materials and the degree of sophistication of testing required. The multitude of complicating factors involved make it impractical to estimate either the losses of technological advances or cost increases due to a cancellation of ETO use.

Limitations

This study was limited to a description of the problems. There was no data to provide information regarding the value of returned equipment treated or the amount of ETO used in these treatments. A similar problem existed for the plant materials treated with ETO.

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THE ECONOMIC IMPACT OF CANCELLATION OF ETHYLENE OXIDE USE ON THE STORED PRODUCTS INDUSTRY

INTRODUCTION

This report presents a partial analysis of possible economic impacts of an ethylene oxide (ETO) cancellation on the stored products industry. Stored products are spices, natural seasonings (herbs and dehydrated vegetables), and nut meats. ETO is used to treat stored products that are used directly by consumers, or institutional users, or as an ingredient in convenience foods prepared by the food processing industry. Today many of the convenience foods purchased by the consumer are packaged in an uncooked condition. The use of spices and other seasonings in uncooked prepackaged containers enables the consumer to prepare a meal that tastes similar to one that is freshly prepared. Stored products frequently contain microbial populations which can lead to spoilage of these convenience foods. ETO fumigation reduces these potentially harmful microbial populations prolonging the shelf-life of these convenience foods.

The microbial organisms of concern include pathogenic bacteria, toxigenic molds, and other organisms which contribute to food spoilage. Many spices and seasonings are imported from less developed countries where sanitary conditions are difficult or impossible to maintain due to tropical climate and intensive hand-labor. Contamination is unavoidable during harvest and after-harvest handling. Certain stored products are also subject to insect infestation. ETO fumigation for microorganisms also kills these

insects thus avoiding a separate fumigation. If no evidence of microbial contamination exists, a fumigation with methyl bromide is often made for insecticidal purposes. Methyl bromide is not registered for use as a bactericide.

Current ETO Use

The American Spice Trade Association (ASTA) in a 1978 survey of 26 firms estimated that about one-fourth of all stored products received ETO treatment (2). The quantity of stored products treated per year was estimated to be 99 million pounds.

The formulations of ETO commonly used are either 100 percent ETO or 12 percent ETO plus 88 percent fluorocarbon. An ETO plus carbon dioxide mixture is used to a lesser degree. Most formulations are used in sealed systems where a vacuum is created prior to application. The 100 percent ETO formulation is used in a total vacuum system and the ETO plus fluorocarbon formulation is used in a vacuum system which ranges from nearly total vacuum to approximately 6 p.s.i. (10).

After fumigation, ETO systems are vacuumed again and then flushed with atmospheric air or nitrogen two or three times to remove the residues. The ETO and flush exhausts are vented into water where they form ethylene glycol and are pumped to the sewer. Recovery systems for ETO have existed in the past, but have fallen into disuse for economic reasons (10).

The decision to apply ETO to spices is often made based on the results of microanalysis. The analysis concentrates on the type of microorganism as well as total count. The presence or the suggestion of the presence of a microorganism

of public health significance will always result in a decision to apply ETO. With respect to other organisms and their total level, the end use of the spice will determine if ETO is used. If a particular spice, based on past micro-analyses, requires a high frequency of treatment from shipment to shipment, then a prophylactic treatment is conducted.

ETO treatment is important for spices used in both fresh and frozen processed foods. Treatment is made primarily by the spice processor to meet specifications usually established by the food processor.

Extent of Use

The imported spices and natural seasonings receiving treatment include:

Anise seed
Basil
Capers
Capsicum (chili peppers)
Cardamon seeds
Cassia
Celery seed
Cinnamon
Coriander seed
Cumin seed
Curry and curry products
Dill mint
Fennell seed
Fenugreek
Ginger root
Laurel (bay) leaves
Mace
Marjoram
Nutmeg
Paprika
Parsley
Pepper, black and white
Poppy seed
Origanum
Sage
Savory
Thyme
Tumeric
Other spices

Major imported spices and natural seasonings not receiving treatment include:

Cloves
Mustard seed
Pimento (all spice)
Seasame seed
Vanilla beans

The spices and natural seasonings produced in the U.S. requiring ETO treatment are mainly dehydrated vegetables (chili peppers, onions, garlic, etc.). One to five percent of the U.S. produced seasonings are treated with ETO.

USDA preliminary data estimates a total of 305 million pounds of spices were imported into the U.S. in unpackaged form in 1977 (12). A total of 162 million pounds were varieties normally treated with ETO and 143 million pounds were varieties not treated. The ASTA estimated 860,000 pounds (active ingredient) of ETO are used to treat 99 million pounds of stored products annually (2). If all unprocessed spices (162 million lbs.) were treated the maximum possible amount of ETO needed for spice treatment would be 1.4 million pounds (assume 8.7 lbs. ETO/1000 lbs. spice).

Alternatives

There is no viable chemical alternative to ETO for use on stored products. Propylene oxide has been used for this purpose in the past but has been found to be ineffective.

A leading industrial scientist reports that due to its chemical properties, propylene oxide can at best be only 1/2 as effective in eliminating undesirable organisms as ETO (1). That is, propylene oxide will not reduce bacteria counts to a low enough level to meet FDA and processed food industry requirements. In addition to reduced effectiveness, ASTA reports that the procedure involved with use of propylene oxide would damage many varieties of spices (8). The heat and dwell time reduce the volatile oil constituents essential to the spice (8). ASTA further states: "At the present time none of our members have reported the use of propylene oxide as a sterilizing agent" (3).

The Federal Code of Regulations (5) specifies that 100 percent propylene oxide may be used to fumigate starches, gums, processed spices, cocoa, and processed nut meats (except peanuts). Whole spices are not included. Use of

100 percent propylene oxide is limited to a single fumigation, temperature not to exceed 125°F and time not to exceed 4 hours. Under these conditions propylene oxide is only 1/6 as effective in sterilizing as ETO (1).

An 8 percent propylene oxide, 92 percent carbon dioxide solution is also approved for use in the Federal Code of Regulations (5). Atmospheric or vacuum fumigation can be employed, and because of the reduced amount of active ingredient, the time limit is extended to 16-48 hours at 100°-125°F under atmospheric fumigation and 16-48 hours at 100°F or 12-24 hours at 125°F under evacuated fumigation (26"Hg). In spite of the increased time limits the propylene oxide-carbon dioxide solution is still only half as effective as ETO. The deleterious effects of the heat and dwell time also make this method of decontamination undesirable (1).

The use of 100 percent propylene oxide would not be possible in existing sterilization chambers employing 12 percent ETO and 88 percent fluorocarbon. The conversion costs of changing a sterilizer chamber from ETO use to propylene oxide are not well documented. However, assuming that the existing chamber could withstand the recommended higher treatment pressures, the conversion cost was estimated to be $35,000 per unit (2,3,8).

ECONOMIC ANALYSIS

Assumptions

The short-run qualitative evaluation of the impact of a cancellation of ETO use for the control of microorganisms on stored products is based on the following assumptions and procedures:

1. Federal regulations specify standards concerning both poisonous and/or harmful substances or microorganisms which pose a health

hazard (6). Therefore, the stored products industry must have some means to control biological agents because of the serious implications to human health from product impurities.

2. There is also a serious problem posed by food spoilage in the stored products industry which can be most effectively controlled by ETO fumigation treatment.

3. The alternative to ETO fumigation as a sanitary control measure is propylene oxide fumigation which is of sufficiently reduced effectiveness so as to be unreliable.

Results

Market demand, consumption and production data for stored products are virtually non-existent. For instance, quantitatively determined demand elasticity estimates for spices at the retail or household level do not exist. In general, the impact of ETO removal on the food sector is impossible to accurately determine in any quantitative sense, without the kind of data mentioned. The consumption of spices can however, be roughly divided into three end-use sectors (7):

Sector	Percentage share
Industrial (food processing)	30-35
Institutional (catering)	20
Retail	45-50

The use of stored products, particularly spices and natural seasonings, seems to be extensive in the industrial and institutional sectors. The treatment of the

stored products used in these two sectors is intended to reduce contamination by microorganisms which can decrease the shelf-life of the final product. If ETO treatment were not available and the spices not treated, the value loss through spoilage of food products might be so large that food processors could be expected to reduce their use of traditional spices and flavorings. This would apply to several different parts of the food industry, including meat packing, soup canning, beverages, baking, and fast foods. In addition to the concern over microorganisms contributing to food spoilage, many food processors and caterers set stringent standards for toxigenic substances (e.g. salmonella) in processed food ingredients such as spices.

The retail spice sector could also be significantly affected by ETO removal. An industry spokesman (4) states that some spices are sufficiently price elastic in demand such that a significant increase in price (as a result of a higher technology necessary for decontamination) would reduce their consumption at the household level. The spices whose demand seems to be elastic include pepper, nutmeg, and mace (7). Pepper consumption is susceptible to substitutes, both synthetic and natural (other spices which would not have to be treated). Finally the impact on the stored products industry itself might be considerable. According to industry sources many small firms might shut down completely as a result of ETO removal, not being able to operate without the current sterilization technology. The larger firms could lose some of their market share as both industrial and household consumers of stored products switched to synthetic and natural substitutes.

Limitations

The above analysis is subject to three critical limitations:

1. Any estimate of the economic impact of ETO cancellation, whether in the form of increased costs and/or decreased revenues, may be overstated with regard to imported stored products. Producers (or processors) may be able to have the products treated with ETO outside the United States, prior to their entry, with little, if any, cost increase.
2. A general lack of data pervades the problem; market demand, consumption, and production data are not available. Therefore, quantitative determination of the economic impact of ETO cancellation on the stored products industry and related sectors is impossible.
3. Closely related to 2. above is the fact that the analysis relied almost exclusively on information provided by the stored products industry.

SUMMARY

ETO is used to treat approximately 100 million pounds of whole and ground spices each year (3). This represents approximately 34 percent of all spice imports and 25 percent of the total consumption of spice for culinary purposes. Domestically produced spices receiving treatment are only 1 to 5 percent of the total production (3).

The stored products industry currently uses ETO as a decontamination agent and no viable alternative exists. Very little information exists concerning market demand, consumption and production of stored products, and therefore the economic impact of ETO removal is quantitatively difficult or impossible to determine. Industry sources indicate that the impact might be significant at the industrial (food processing), institutional (catering), and retail (household) levels.

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ECONOMIC ANALYSIS OF ETO USE ON BEEHIVES

INTRODUCTION

This report presents the results of the economic analysis of cancelling the use of ethylene oxide (ETO) for controlling the spread of bee diseases. Bee diseases are found throughout the country with approximately 3 percent of the colonies becoming infected each year (1). Commercial beekeeping involves rotating of equipment (hives, combs and comb foundations) among the various hives owned by the beekeeper. This can result in a rapid spread of disease when a colony becomes infected. Colonies not subjected to exposure by contaminated equipment have natural defenses which prevent rapid spread of disease.

Table 1 contains information on the 11 States currently using ETO. The following data are provided: (a) number of colonies, (b) honey production, (c) value of honey production and (d) value of beeswax production. Bees also contribute to agricultural production through pollination of some crops. A major reason for the maintenance of a viable beekeeping industry is the significance of pollination.

Pest Problem

American Foulbrood (AFB) is a major disease and can spread rapidly when equipment is contaminated with disease spores. ETO kills the spores of *Bacillus larvae*, causative organism of AFB thus, preventing spread of disease. other diseases controlled, include European Foulbrood, Chalkbrood and Nosema diseases (3).

Current ETO Use

Once a colony is infected with AFB, the colony is considered lost. The current procedure for controlling bee diseases where ETO is not available is for the State apiary inspector to burn the equipment, honey and remaining diseased bees. This technique requires the apiculturist to replace the equipment and bees. The adoption of ETO use results in destruction of the bee colony but not the equipment.

ETO is used to decontaminate equipment after infection by one of the several bee diseases previously listed (3). Usage of ETO to control bee diseases represents a relatively new technology. Scientists are still experimenting with various use techniques attempting to determine the preferred technique(s) to use. The decontamination reduces the number of pathogenic organisms; thereby, reducing the likelihood of disease spread to other hives. The use of ETO enables the reuse of hive equipment after decontamination. A new colony can be established immediately.

ETO is currently approved by EPA (Table 1) on a "special local needs" (24c) or an experimental exemption in 11 States. The States currently using ETO are located in the East and Southeast regions of the country and in Oregon. These States are not major honey producers, accounting of only 13 percent of U.S. production. The lack of established treatment techniques for the use of ETO on bee equipment and the newness of the technology partly explain the use of ETO in only 11 States. Use has been increasing as more States are becoming familiar with ETO use and are finding it an acceptable alternative to the burning of equipment. Approximately 1500 pounds a.i. of ETO are used per year for bee disease control (3). Usage rates vary from .11 to 1.35 pounds ETO per hive treated (Table 2). Because this is a new technique and there has not been

adequate experience to establish a narrow treatment range.

Because ETO is a relatively new technology, it is reasonable to assume that over time the use of this chemical would become more widespread. Beekeepers are more willing to call a bee inspector when a colony shows indications of disease knowing that only the bees will be destroyed. Burning has been used to destroy the infected hives and those nearby which may be infected. Therefore, use of ETO could over time reduce the incidence of bee diseases.

Based on information supplied by USDA apiculturists, replacement equipment (one hive) would cost about $100 (1). A beehive if properly maintained (painted and cleaned on a regular basis), has an idefinite life span. A well maintained 20 year old beehive would have about the same market value as a new one. ETO treatment costs about $10.00 per hive including an average of $2.25 for the material. Burning costs include digging a pit to burn the equipment in, supervision of burning, and covering the ashes with dirt. These costs would vary. A $10.00 cost was assumed by the assessment team.

Alternatives

There are no registered pesticide alternatives to ETO for decontamination of equipment. Burning of equipment to destroy the disease spores has been the required treatment in most States. Equipment can be decontaminated by boiling the parts in lye solution for an extended period of time. However, this causes the wood to deteriorate and destroys metal fasteners, comb, comb foundation, and paint. It is generally easier for the commercial operator to burn the equipment than go to the trouble of using a lye solution.

ECONOMIC ANALYSIS

Assumptions and Procedures

1. The most feasible alternative, burning the equipment, was specified by the ETO assessment team. This determination was made in consideration of State regulations, efficacy of the possible alternatives, product labels, and treatment costs. There is another alternative (boiling in lye) which is more costly than burning, and not used by commercial beekeepers.

2. A loss of honey production for one year would occur with the alternative to ETO. An additional year of production loss could occur with any type treatment if the colony became diseased at the wrong time of year, due to the inability of the beekeeper to obtain a new queen.

3. Partial budgeting techniques were used to estimate the short term impact of an ETO cancellation. It was assumed that there were no changes in the cost of treatment.

Results

The annual loss to beekeepers of an ETO cancellation would be $500,300 (Tables 2 and 3). Beekeeping equipment lost to burning would be $408,000 (Tables 2).

Honey production would be expected to decrease in the affected States as a result of the loss of one year's production in the affected hives (1). Based on 1976-78 prices and yields, total production losses in the affected

States are valued at $92,300 (Table 3). This figure represents about one tenth of one percent of the total value of honey production for the 11 States (Table 1).

In the longer run more States will adopt the use of ETO to control the spread of bee diseases. The widespread use of ETO would have two long term impacts on beekeepers. First, it would increase the use of ETO for control of disease. Second, widespread use of ETO could result in decreased incidence of bee diseases (1). It has been observed in those States where ETO is currently used, that beekeepers are more willing to bring weakened hives to the attention of State inspectors since an economic savings is realized (1). Bee diseases are usually spread either from disease spores on reused equipment or from bees in healthy hives robbing weak diseased hives. The elimination of disease spores on equipment and the willingness of more producers to contact inspectors should decrease the incidence of bee diseases over time. There is no information to provide an adequate method to estimate these potential impacts. Currently, ETO is not used on all equipment in those States where use is registered. Some burning still takes place. States do not have enough experience with ETO use to accurately project the number of chambers which could be efficiently used.

Limitations

(1) Because ETO represents a relatively new technology, it is reasonable to assume that over a period of time use will increase. For example,

if one half the diseased hives in the United States were treated with ETO, 122,500 hives would be treated annually with a total ETO use of 42,875 pounds a.i. assuming 0.35 pounds a.i. per treatment.

(2) In estimating losses, it was assumed that honey in diseased hives would not be lost with ETO treatment. It is not clear that this would be the case. Residues from the treatment of honey with ETO may result in the honey being unmarketable. Information was not available to clarify this. If this honey could not be marketed this would reduce beekeeper losses due to an ETO cancellation by $92,300.

SUMMARY

The cancellation of ETO use on beehives would result in losses to beekeepers of $500,300. However, this cancellation would result in the loss of a new technology which has not yet been adopted in most States. The analysis of ETO use is only in those States where it is registered. There is no current national registration. While the benefits of nationwide use of ETO cannot be accurately projected, it is reasonable to expect usage to increase at a proportional rate so annual use would be about 42,875 pounds, a.i., ETO. Currently those States using ETO have not used it to replace entirely the burning of hives due to the slow disemination of the technology.

Table 1. Number of colonies, honey production, and value of honey and beeswax for those States currently using ETO, 1976-1978. a/

State b/	Number of colonies	Honey production	Value of honey production	Value of beeswax production
	Thousands	1,000 Pounds	1,000 Dollars	
Alabama	46.3	1,035.7	659.7	38.7
Connecticut	8.0	205.3	215.0	7.0
Delaware	1.8	87.0	78.7	3.7
Maryland	13.0	407.3	309.3	14.7
New Hampshire	4.0	122.7	131.3	4.0
New Jersey	36.3	1,114.7	940.7	27.0
New York	116.7	4,893.3	2,658.3	122.7
Oregon	55.3	1,819.3	913.7	49.7
Tennessee	152.0	3,821.3	3,018.0	112.3
Virginia	78.3	1,952.3	1,292.0	42.0
West Virginia	92.0	2,118.7	1,940.7	55.3
11-State Total	603.7	17,577.6	12,157.4	477.1
Other States	3,634.6	184,822.4	94,244.2	4,682.6
U.S. Totals	4,238.3	202,400.0	106,401.3	5,159.7

a/ 1976-78 3-year averages from "Honey, Preliminary 1978, revised 1976-1977," USDA, ESCS, Sehy 1-3 (79), January, 17, 1979.

Table 2. Increased control costs for bee disease controls without ethylene oxide

State	Number of hives treated per year a/	Quantity of ETO used b/ (pounds a.i.) per hive	Control costs without ETO c/
			Dollars
Alabama	400	0.1	40,000
Connecticut	100	1.35	10,000
Delaware	100	0.18	10,000
Maryland	300	0.50	30,000
New Hampshire	200	0.25	20,000
New Jersey	1,500	0.23	150,000
New York	130	0.92	13,000
Oregon	300	0.20	30,000
Tennessee	400	0.25	40,000
Virginia	300	1.10	30,000
West Virginia	350	0.28	35,000
TOTAL	4,290		408,000

a/ From "USDA/State and EPA Cooperative Assessment of Ethylene Oxide Uses in Agriculture," USDA and USEPA, 1978.

b/ "Honey, Preliminary 1978, Revised, 1976-1977," USDA, ESCS, Sehy 1-3 (79), January, 17, 1979.

c/ Value of average hive ($100) times the number of treatments (replacements) per year. Treatment costs were assumed equal.

Table 3. Expected production losses resulting from cancellation of ethylene oxide

State	Number of hives treated per year a/	Yield per colony b/	Honey production b/	Average price per pound b/	Value of honey production loss
		Pounds	Pounds	Dollars	1,000 Dollars
Alabama	400	22	8,800	.638	5.6
Connecticut	100	26	2,600	1.04	2.7
Delaware	100	33	3,300	.875	2.9
Maryland	300	31	9,300	.754	7.0
New Hampshire	200	31	6,200	1.07	6.6
New Jersey	1,500	31	46,500	.845	39.2
New York	130	42	5,460	.544	3.0
Oregon	300	33	9,900	.500	4.9
Tennessee	400	25	10,000	.786	7.9
Virginia	300	25	7,500	.653	5.1
West Virginia	350	23	8,050	.903	7.3
Total	4,290				92.3

a/ USDA/State and EPA Cooperative Assessment of Ethylene Oxide uses in Agriculture, USDA and USEPA, 1978.

b/ "Honey, Preliminary 1978, Revised, 1976-1977," USDA, ESCS, Sehy 1-3 (79), January, 17, 1979, Average 1976-1978 yields and prices.

SOURCES CONSULTED

(1) Shimanuki, H., Chief, USDA, SEA-FR, Bioenvironmental Bee Laboratory, Beltsville, MD., Personal Communication.

(2) USDA, 1979, "Honey, Preliminary 1978, Revised 1976-1977," ESCS, Sehty 1-3 (79), January 17.

(3) USDA, 1978, "USDA/State/EPA Assessment of Ethylene Oxide Uses in Agriculture," August.

ECONOMIC ANALYSIS OF ETO IN USDA LABORATORIES

INTRODUCTION

This report presents the results of the economic analysis of cancelling the use of ethylene oxide (ETO) in USDA research laboratories. ETO is used in 3 high containment scientific research laboratories to prevent the spread of plant and animal disease pathogens. These laboratories conduct reseach into domestic and exotic (foreign) plant and animal diseases, and one laboratory functions to test exotic biological control agents for plant pests prior to release for domestic use. Some of the pathogens (such as swine flue virus) are of human health concern as well as animal and plant concern.

Items treated include only: plastic laboratory equipment which can be reused after ETO treatment; electronic equipment prior to reuse or being sent out of the laboratory for repairs; various heat and moisture sensitive devices prior to use; movie film taken for veterinary school and APHIS training on exotic animal diseases; and in an experimental program to decontaminate certain seeds being imported into this country.

Current ETO Use

The USDA/State and EPA ETO Assessment Team estimated that about 500 pounds a.i. of ETO are used annually in these laboratories (2). ETO is used only when no known substitute exists (2). All treatments are conducted in vacuum evacuated gas sterilizers with the gas being vented to the air discharge systems. Discharge air is passed through filtration systems and discharged through stacks located on the roofs of the buildings.

Alternatives

There are no registered alternatives to ETO that would not damage or destroy the items being treated with ETO (2). A possible alternative would be to replace all equipment currently treated with ETO. Some plastic equipment could be replaced with glass equipment. Most equipment currently treated would have to be replaced each time decontamination was required. Photographic film would require a shift to video tape filming with the tape equipment being located outside the containment laboratory. The imported seeds could not be treated with an alternative, and therefore could not be imported.

ECONOMIC ANALYSIS

Assumptions and Procedures

The estimated short-run economic impact of a cancellation of ETO use in scientific laboratories was based on the following assumptions and procedures:

1. The scientific laboratories would continue to perform current functions. Budget constraints due to increased costs without ETO which may slow down research were not considered.
2. The biologists assigned to the USDA/State and EPA ETO Assessment Team indicated that there are no registered alternatives to ETO which would not destroy the equipment or seeds being treated.
3. Partial budgeting techniques were used to estimate the impact of an ETO cancellation.

Results

The cancellation of ETO use in USDA research laboratories could result in increased annual equipment costs of $1.1 million to replace equipment currently treated with ETO (Table 1). The used equipment would have to be steam sterilized prior to disposal. Steam treatment costs would be approximately equal to ETO treatment costs. In addition, the Plum Island laboratory would require video tape capabilities costing an estimated $50,000 for equipment and necessary building modifications. Actual costs would depend on system design and competitive bids.

The increased annual operating costs include replacing electronic and plastic equipment which could not be treated with any other technique. Much of this equipment was designed to be decontaminated with ETO. Equipment manufacturers may be able to redesign some equipment so eventually part of the increased cost could be eliminated. The magnitude of eventual cost reductions depends on the ability of manufacturers to redesign equipment so parts requiring decontamination can be treated with an alternative or are low enough cost to be truly disposable. The redesign and manufacturing of this equipment would be expected to take considerable time. Potential returns to the equipment manufacturers and design requirements would determine whether manufactures would develop this new equipment. This analysis was beyond the scope of this study and would require information from equipment manufacturers which generally is proprietary.

Table 1. Annual increased costs for equipment resulting from an ETO cancellation a/

Equipment type	Value of equipment
Equipment repaired out of laboratory b/	$ 68,000
Plastics c/	75,000
Lyphilizers d/	800,000
Mash Units d/	150,000
Cameras	36,000
Total	$1,129,000

a/ Price information and usage provided by USDA/State and EPA, ETO Assessment Team from manufacturers' price lists and ETO equipment treatments at the laboratories.

b/ This is electronic equipment which must be removed from the laboratory for major repairs.

c/ This plastic equipment was designed to be disposable and is treated to reduce expenses and includes plastic equipment which is custom made for certain functions. Some of this equipment could be replaced with steam treatable glassware, but at a much higher cost.

d/ This electronic equipment must be decontaminated after each use to prevent contamination of biological samples.

SOURCES CONSULTED

(1) Richmond, J.Y., 1978, Staff Scientist, Plum Island Animal Disease Center, SEA, USDA, Personal Communication, July.

(2) USDA, 1978, "USDA/State and EPA Assessment of Ethylene Oxide Uses in Agriculture," August.

(3) Irish, K.R., 1978, Staff Scientist, Plant Disease Research Laboratory, FT Dietrich, SEA, USDA, Personal Communication, July.